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## A Contribution to the Physiology of Tendrils.*

BY D. T. MACDOUGAL.

*Entada scandens* Benth. is an example of the group of plants which have developed climbing organs from leaves, and which exhibits the transition forms between the initial leaf and the tendril bearing organ.

The genus *Entada* includes five climbing species, some of which have the power of grasping supports by means of the stalks of the pinnae, the others have converted the terminal pair of pinnae into a highly specialized pair of tendrils. *Entada scandens* and *E. polystachys* belong to the latter class.

The adult plant of *E. scandens* consists of a roughened, thick, densely branching vine, which climbs over small trees and shrubs, attaining great distances and heights. In some instances the apex of the principal stem has been found 100 metres from the root.

The leaves are 15–30 cm. in length and consist of a short petiole and an elongated midrib bearing a terminal pair of cylindrical tapering tendrils 5–6 cm. in length. The base of the petiole forms a large pulvinus capable of movements through an angle of about 100 degrees in response to heat and light stimuli. The apical portion of the leaf bearing the tendrils is exposed and the tendrils become active before the pinnules are unfolded. The leaves are generally securely anchored before the green surfaces are de-

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veloped by this arrangement. If a tendril fails to grasp a support it soon dies and is cast away in the same manner as useless leaves or pinnae.

Concerning the history of the development of tendrils on seedlings, Schenk says "Von *Entada scandens* habe ich eine Keimflanze im Bonner Bot. Garten beobachtet. Aus dem dicken grossen Samen kommt ein langer dünner Hauptstengel hervor, dessen erste Blätter keine Spreiten entwickeln, sondern am Ende des Stieles nur je eine Doppelranke tragen. Erst wenn der Stengel einige Fuss hoch ist, folgen auf diese rankenartigen Niederblätter normale gefiederte Blätter mit endstandiger Doppelranke."*

Seedlings grown in a plant house at the University of Minnesota exhibit four or five basal club-shaped bracts attaining a length of 8 or 9 mm. before dropping away. The fifth leaf consisted of a short midrib bearing a pair of irregular stubby pinnae 2 mm. in length, near the base, and a pair of tendrils springing from a point 1 mm. from the tip of the midrib. The basal pinnae bore lateral papillose extensions 8 mm. in length representing pinnules. The tendrils attained a length of 7 mm. and assumed the normal position but were not at any time capable of reaction or of grasping an object. The entire petiole and midrib measured 17 mm. and reached its maturity at a time when the plant stood 19 cm. above the ground. The sixth leaf was furnished with two pairs of lateral branches beside the apical pair of tendrils. In other plants the imperfect tendrils or the branching of the rudimentary rachis did not occur until the sixth leaf had appeared. The leaves successively increased in size and were functionally perfect both as to tendrils and laminae at a varying distance from the base.

## ANATOMY.

The tendrils are tapering cylindrical, 5–6 cm. in length, when first exposed they adhere by the adjoining surfaces in such manner as to present a D-shaped outline, and do not separate and become irritable until a length of 1.5 or 2 cm. is attained. In the mature tendril the arrangement of tissue is strictly isodiametric. A radius

* Beiträge zur Biol. d. Lianen 1: 155. 1892.

of the cross section would expend one-sixth of its length in passing the medulla and xylem, two sixths in passing through the phloem and three sixths in the cortex and epidermis. The structure allows great flexibility, rapidity of reaction, and admits of curvature in any direction. A further adaptation to these demands consists in the extremely small size of the cells.

The epidermal cells are rich in protoplasm, the outer walls are markedly outwardly convex, and the three diameters of the cell are nearly equal. The cortical cells impinge directly on the epidermis, and a most notable fact is the entire absence of an external layer of collenchyma. The cortex contains a large amount of chlorophyl and the globoid cells are arranged in six to eight layers with marked intercellular spaces. The inner boundary of the cortex is marked by a sheath consisting of one to three layers of cylindrical parenchymatous cells completely filled with a densely granular substance resembling the gluclosides. Similar cells occur in the phloem and even in the xylem. The medulla is composed of very small elongated cells which have become sclerotized. The tendril then consists mechanically of a cylindrical core of mechanical elements enclosed in a thick cylinder of motor tissue, both of which have a strictly radial symmetry.

## IRRITABILITY.

The tendrils appear equally sensitive over their entire length and at a temperature of 33° C. react to contact after a latent period of 5–10 seconds and regain the original position in 10–12 minutes if the contact is but momentary. If a tendril is pressed by means of tweezers or the thumb and finger, no curvature is induced, since the organ is equally stimulated to curve in opposite directions.

When plants growing in the open air are examined, it is difficult to find them in a "normal" or unirritated condition, since they are in a state of rapid circumnutation, are very flexible and easily swayed by the wind; then the contiguity of the two tendrils in a pair allows them to be thrown together very easily. As a result of these facts, the tendrils are generally more or less curved into a hook form, in which condition they will more readily grasp a twig

or other support. The most advantageous position in general would be when the organs are separated with their axis forming an angle of 45 degrees, and the tips curved in any direction except toward the other tendril. If the movements of the leaf should bring a branch between the arms of the Y thus formed, it will be enclosed in 50 to 80 seconds, which is perhaps the most efficient work of any climbing device.

## The Sensory Zone.

The sensory zone apparently consists of the single layer of epidermal cells. These cells, seen from the surface, exhibit the greatest diameter tangentially, and seen in cross section the diameters are nearly equal. The nucleus occupies a central position, and the ectoplasmic layer on all sides is extremely thick and very densely granular. It is of course impossible to discover the condition of these elements in an unstimulated condition.

The outward convexity of the external membranes would offer most advantageous conditions for the appreciation of delicate stimuli. The contiguity of the motor cortex cells with numerous interprotoplastic connections would facilitate the transmission of impulses.

## Mechanism of Curvature.

The method of production of curvature was determined by measurements of the cortical and epidermal cells of the convex and concave sides of curved tendrils and comparison of the same with data obtained from straight organs. The measurements of one set are given below:

### Table I.

*Measurements of opposite sides of straight organs.*

| | Number of Cells. | Length. | Average. | | Number of Cells. | Length. | Average. |
|---|---|---|---|---|---|---|---|
| Epidermis | 8 | 797 | 12.1 | Epidermis | 9 | 100 | 11.1 |
| | 5 | 102 | 20.4 | | 5 | 100 | 20. |
| | 4 | 96 | 24. | | 6 | 100 | 16.6 |
| (A) | 4 | 104 | 26. | | 4 | 110 | 27.5 |
| Epidermis | 10 | 100 | 10 | Epidermis | 10 | 100 | 10 |
| | 7 | 100 | 14.3 | | 6 | 98 | 16.3 |
| | 6 | 94 | 15.6 | | 6 | 100 | 16.6 |
| (B( | 4 | 94 | 23.5 | | 4 | 98 | 24.5 |

TABLE II.

*Measurements of tendrils stimulated and quickly killed. Sets of cells directly opposite in the same section were measured.*

| Convex Side | | | Concave Side | | |
|---|---|---|---|---|---|
| Number of Cells. | Length. | Average. | Number of Cells. | Length. | Average. |
| Epidermis 10 | 100 | 10 | Epidermis 12 | 100 | 8.3 |
| 8 | 95 | 11.9 | 7 | 100 | 14.3 |
| 6 | 100 | 16.6 | 8 | 105 | 12.5 |
| 4 | 100 | 25 | 9 | 100 | 11.1 |
| Epidermis 10 | 100 | 10. | Epidermis 12 | 100 | 8.5 |
| 8 | 105 | 13.1 | 8 | 100 | 12.5 |
| 5 | 104 | 20.8 | 7 | 108 | 15.4 |
| 5 | 95 | 19. | 7 | 100 | 14.3 |
| 3 | 100 | 33. | 5 | 100 | 20. |

The average length of the four sets of cells of a straight tendril were 19, 17.8, 14.5, 15.6 with a grand average length of 16.725. The average lengths of the cells from the convex sides were 14.5 and 16.2 with a grand average of 15.15. The average length of the cells from the concave sides of the same tendrils were 11.25 and 13.

It is found, as a result of these measurements, that the cells of the concave side have undergone such diminuition in the longitudinal axis as to measure less than the average normal cells and less than the corresponding cells of the convex side. The cells of the convex side have not increased beyond the average of normal cells. It is evident, therefore, that the curvature of the tendrils is to be ascribed to the action of the cells becoming concave. This action presumably resembles that of the pulvinus of *Mimosa*. Such mechanism is in fact demanded by the structure of the tendril and the rapidity of the curvature necessary to make the motion efficient and economical.

MORPHOLOGICAL CHANGES DUE TO CONTINUED PRESSURE.

The greater portion of the tendril is usually engaged with the support and the free basal portion is rarely a centimeter in length. After the apical portion has engaged the support the basal portion becomes curved in some instances sufficiently to form one complete spiral. In no instance, however, was the arrangement of the

freely curved base sufficient to give an elastic or springing attachment of the leaf which is, in consequence, held in its position quite rigidly.

The portions of the tendril in contact with the support show an increased diameter and a general thickening of the cell walls. The contents of the glucoside cells have nearly disappeared, suggesting that this substance functions as reserve material.

In the outer region of the glucoside cells a ring of libriform tissue is formed which is four or five layers in thickness on the concave side and scarcely half as much on the convex. This ring, as well as the woody, is lignified. The cortex has increased in thickness by simple enlargement of cells. The subepidermal layer has perhaps undergone division forming irregular and much compressed cells. The cells of the epidermal layer of the concave side have undergone enlargement in a radial direction so that this diameter is two or three times as great as the diameter parallel to the surface of the organ. The increase is principally in the form of a greater convexity of the outer wall. The entire concave surface of the tendril has epidermal cells forming irregular papillae, consisting of a group of six to fifty cells. Such an arrangement would fasten the organ quite firmly to the support. The epidermal cells of the convex side have undergone no marked changes except in increase in the axes parallel to the surface and decrease of the convexity of the outer walls.

## General Conclusions.

Schenk has pointed out that the theory of Darwin, that all tendril-bearing plants were originally twiners, is at least not applicable to leaf-climbers, and to climbers with tendrils derived from leaves. Leaf-climbers were doubtless derived from species with elongated weak internodes which grow up through the tangles of jungles. The weight of the stem would be supported upon the neighboring plants by means of the leaves and other lateral members. The movement of the surrounding plants by the wind would tend to produce injuries in the supporting members. The development of the power of response to contact would enable the

ancestral climbers to avoid this injury, and at the same time climb more effectively. The development of the irritability to contact in the extremities of the leaf and the transformation of such members into filiform organs would be a natural consequence, and an inevitable one in species bearing large or extended leaves, such as the one under consideration. Furthermore, the general phylogeny of *Entada* would not indicate that it has been a twiner at any time in its existence.

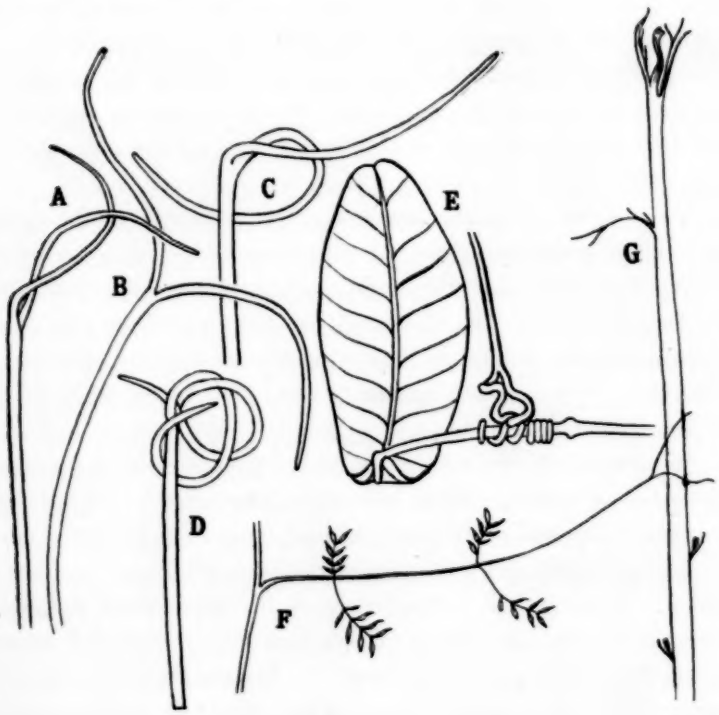
A consideration of the features of the irritability of the tendril leads to the conclusion that the efficiency of the tendril is by no means dependent upon the degree of dorsiventrality exhibited. The isodiametric tendrils of *Entada* are quite as effective in grasping supports and exhibit as great a degree of delicacy of sensorial action as any organs yet examined, and they show no tendency toward dorsiventrality.

Dorsiventrality is induced only by pressure of the support where it is of some benefit in securing a firmer hold. The delicacy of reaction depends more upon centralization and concentration of the woody cylinder, a fact to which I have previously called attention. The lack of collenchyma in the tendrils of *Entada* is probably due to the almost entire absence of torsional strains during the curvature of the tendril. The collenchyma sheath of many tendrils is doubtless to resist the effects of torsional strain. Attention is to be called here to the fact that, in the tendrils of *Entada*, nearly the entire length of the tendril engages the support in a single continuous spiral, and free coiling forms only part of a circle in the basal portion of the organ.

The mechanism of curvature is seen to resemble that of tendrils of *Passiflora* and the roots of *Zea*, in which the mechanical elements are centralized and in which the motor tissue occupies a relatively great portion of the cross section. Curvature is effected by the contraction of the cells of the side becoming concave, a condition demanded by the rapidity of reaction.

The work recorded in this paper was largely performed in or near the botanical gardens at Castleton and Bath in Jamaica, in the summer of 1897, and the writer is indebted to Hon. Wm.

Faucett for the privileges of the gardens, access to collections and much valuable information.




**Explanation of Figures.**

The tendrils of *Entada scandens* Benth.

A–E, illustrating positions taken by tendrils. A and C, position resulting from mutual stimulation and nutation. B, normal or unstimulated tendrils. D, curvatures produced by filaments of spider's web. E, tendril attached to leafy branch of supporting plant. F, compound leaf with terminal pinnae converted into tendrils. G, shoot of seedling. The fifth leaf exhibits a terminal pair of tendrils and a single pair of foliar pinnae.

## Contributions to Japanese Characeae.—III.

By T. F. Allen.

### A.—NEW SPECIES OF NITELLA.

The following Japanese species of *Nitella* seem to belong, properly, to the subdivisions *diarthrodactylae*, *homoeophyllae*, *monoicae*, *subflabellatae*, *congestae*, *microsporae*. This group, founded on *N. axillaris* A. Br. (from Caracas, S. Am.), is, in general, characterized by a condensation of the fertile verticils in close spike-like racemes (the new *N. rigida*, *Saitoiana* and *Tanakiana*); or in dense axillary clusters (*N. axillaris* A. Br. and *N. Morongii* Allen).

The group has been divided by Nordstedt into two: (1) With small spores, 290 to 340 long, and (2) With large spores, 400 to 450 long; the capitula of the latter are either terminal or axillary. The species with smaller spores may be arranged as follows (according to size of spore): 250, *N. Morongii* Allen; 275, *N. Saitoiana*; 285, *N. rigida*; 290, *N. axillaris* A. Br.; 306, *N. Tanakiana*; of these *N. rigida* Allen bears fruit in elongated axillar, and terminal spikes; *N. Tanakiana* Allen also, but the spikes are rather like condensed upper verticils; *N. Saitoiana* Allen has more open upper fertile verticils; while *N. Morongii* Allen bears fertile verticils in dense axillary clusters.

#### Nitella rigida sp. nov.

Plants erect, strict, almost rigid, 15–20 cm. long; branches strictly erect, not spreading, lower sterile leaves 4 to 6 in a whorl 6–8 cm. long; divided near the apex into 3–5 short branches, which usually are once again divided into two short terminals. From the sterile verticils, long "spikes" of fertile leaves arise, which may exceed the length of the stem; the fertile verticils are at first remote, but become crowded above; the entire "spread" of a fertile verticil is scarcely more than 3 or 4 mm.; the fertile leaves, usually 5 in a whorl, are 2- (rarely 3-) divided; the first segment 54–60 in diam.; *the first node* bears 5 divisions; *the second node* carries 2 or 3 terminals; the second segment of the leaf is 45–60 in diam.; the terminals are about 25 in diam., rarely 3-celled and very rarely subdivided; the ultimate cell is a mucro 15 at base by 100 long; the oögonia are single at the node of the leaf, tapered; the oöspore is 285 long by 272 broad, with five rarely six, prominent, sharp ridges; the membrane of the spore is cov-

ered by papillae, not pointed, about 1 $\mu$ long and about three in 5 $\mu$; the antheridia are about 160 in diam., varying with age.

Collected in Shakuhachi pond, Kyoto, Japan.

### NITELLA TANAKIANA sp. nov.

Plant 20–25 cm. long, rather simple, sparingly branched; verticils of two sorts quite distinct, lower sterile remote, consisting of six leaves divided near the end into 2 or 4 shorter terminals, 6 or 7 mm. long, which are often again subdivided; the terminals are, as a rule, 3-*celled*, the ultimate cell a mucro; the upper fertile leaves are very short, and at the upper part of the stem the verticils become gradually smaller and closer or elongated shoots arise from the lower sterile verticils and bear only close whorls of fertile leaves (having the appearance of spikes); the fertile leaves are 2-divided (very rarely, a third division has been seen); the *first node* consists of 3 or 4 divisions, the second of 2 or 3 (rarely 4) unequal terminals; the terminals are 3-celled (with only an occasional exception) the first cell *two-thirds the length of the entire terminal*, the second cell tapering somewhat to the third which is a mucro; the stem is about 333 $\mu$ in diam.; the first segment of a leaf 130, the second 116 to 58, the third 75 tapering to 50, the mucro, almost triangular, 30 to 45 at base and 80 to 116 long; the mucro drops easily and early; mature leaves are rarely found with mucrones.

The species is monoecious; oögonia occur on both nodes of the leaf ,often aggregated. The oöspore is 306 long by 272 broad, with 6 (or 7) sharp and prominent ridges. The membrane is characterized by granulo-reticulate markings, small pointed granules are arranged in reticulated series with a faint connecting line, and with larger granules at the junction of the irregularly hexagonal reticula.

The relationship of this interesting species seems clearly to be in the group with *N. rigida* Allen, from which it differs by its more flexible habit, the character of the terminals and of the oöspores

This plant was collected in Hirosawa pond, Kyoto, Japan.

### NITELLA SAITOIANA sp. nov.

Plants 15–20 cm. long, somewhat branched, with numerous whorls of long leaves which become crowded and abbreviated above. In the lower part of the stem the verticils are 3–4 cm. distant, the leaves about 3 cm. long, equaling the length of the internode. The lower leaves are sterile and divided above the middle into 3 or 4 segments, which area gain divided (usually) into 2 or 3 very short mucronate terminals. The leaves

of the upper verticils are shorter but still diffusely spreading and not condensed into a congested mass; they are 2-, rarely 3-divided; the *first node* bears 3–5 divisions and is at times fertile, the *second* 2 or 3, and the *third*, when present 2 (rarely 3 terminals). The stem is 400 in diameter, the verticil consists of 7 or 8 leaves; the first segment of the leaf is 286 in diameter, the second 200, the third 143 and the terminal 143. The terminal is frequently 3-celled, the division being ¾ near the upper extremity; it does not taper markedly to the mucro. The mucro is about 25–35 in diameter to 70–80 long, not very evanescent. The antheridia are about 225 in diameter. The oögonia are isolated usually, but often aggregated at both nodes, more often on the second node. The oöspores are 275 long by 240 broad, with five or six ridges; the membrane is marked by long and short granules irregularly arranged.

This species seems to belong in a group with *Nitella rigida* and *N. Tanakiana*, and to be slightly related to *N. gracilis;* from the former species it is distinguished by its more diffuse habit, the fertile verticils not on spike-like shoots, from *N. gracilis* by numerous characters, though the tendency to the *three-celled* terminal is seen in all these species.

Collected in Sweibachi-ike pond, province Kyoto, Japan. Named for a faithful and industrious collector, Kenzo Saito.

### B.—NOTE CONCERNING NITELLA ORIENTALIS ALLEN, WITH DESCRIPTION OF A NEW ALLIED SPECIES.

NITELLA ORIENTALIS Allen, Bull. Torr. Bot. Club, **21**: 524. 1893.

This plant varies greatly from different localities, not only in size, but in the divisions of the leaves. The leaves are often only 3 times divided, often 5 times; the terminals, often very short (brachydactylae) are again quite long (macrodactylae), so that I have been in doubt about referring the species to the "*polyglochin*" series. The antheridia vary from 75–300 in diameter. The oögonia are usually clustered, but sometimes isolated *never on the first node;* the oöspores vary from 340–375 long and 285–320 broad, always with 7–9 ridges. The surface of the spore seems to have a superficial and dense grumous layer of felted fibres, covering a granulated surface, but the granules are not pointed and do not protrude through the felted layer.

This species seems to me to belong rather to the *macrodactylae* division, and to be allied to my new *N. expansa*, to which its

similar habit of growth associates it. Formerly, owing to the very unequal and extremely abbreviated terminals, I referred it to the *brachydactylae* section with which it seems ill-assorted.

*N. orientalis* and *N. expansa* are similar to *N. gracilis* in habit of growth, but the oögonia are clustered and the oöspores differ. The divisions of the leaf and the character of the terminals also separate these two species. The tendency to abbreviated terminals and to more than three leaf-nodes in *N. orientalis* points to a sort of transition to the species of the *brachydactylae* series (which abound in Japan).

### NITELLA EXPANSA sp. nov.

Plants 10–12 cm. high, diffusely branched, "bushy;" leaves spreading, diffuse, stem 450 in diam; verticils approximate, of 5 or 6 leaves; leaves spreading, often longer than the internodes, 3 (rarely 4) times divided; the first segment less than half the length of the entire leaf, 200–265 in diam; the first node, with 5 or 6 divisions, usually sterile; the second segment 160–170 in diam; the second node, *with three divisions*, fertile; the third segment 145–155 in diameter; the third node, with 2 or 3 divisions, fertile; the fourth segment, 100–120 in diam., usually terminal. The mucro, 34 in diam., 80–100 long; the terminals are unequal, 1–3, often very short; the oögonia are usually isolated, but often aggregated on the second and third nodes, *not seen on the first node, but often found in the verticil, on the stem*. The antheridia about 200 in diameter; the oöspore 245 to 250 long by 204 to 220 broad, with five or six sharp ridges, at second and third nodes, the surface *quite smooth*.

In its aspect it is quite similar to *N. gracilis;* the first node of the leaf also bears four divisions and is sterile. It is similar to *N. orientalis* in the unequal terminals, one of which is often very short, but the second node of this species is 3-times divided and the oöspore is smaller with a smooth surface (granular in *N. orientalis*).

Collected in "Shakuhachi-bori water," Kyoto, Japan.

## C.—DESCRIPTION OF A NEW JAPANESE NITELLA ALLIED TO OUR AMERICAN SPECIES, N. TRANSILIS ALLEN, AND N. TENUISSIMA DESV.

### NITELLA GRACILLIMA sp. nov.

Plants very delicate; 6 to 8 cm. high; branched, but not diffusely; branches and leaves mostly rather erect, not spreading; stem 80 to 90 $\mu$ diam.; verticils consist of 6 leaves; leaves somewhat erect, not diverging from the stem, not quite equal to the

internode (aspect of *N. transilis* Allen); leaf usually thrice divided; the *first segment* nearly half the length of the entire leaf; 54–60 in diam.; *first node* has 6–7 divisions; sterile; the *second segment*, shorter, 40 to 48 in diam.; the *second node* bears four divisions, fertile; the third segment, 30 to 35 in diam.; the third node, fertile, bears 4 or even 5 terminals; the terminals slender, longer than the preceding segment and nearly as long as the first, 34 in diameter, one-celled, except the mucro, which is about 15 in diameter by 55 to 68 long (large for the size of the plant).

The oögonia are isolated at the second and third nodes of the leaf; the oöspore is 190 to 197 long by 150 to 156 broad, with six or seven sharp wavy ridges. Antheridium 125 to 135 in diam. The *spore membrane is remarkable in being covered with coarse elevated elongated granules.* The ridges are acute at their tops, but spread at their bases, where they join the surface of the shell; these bases are wavy-toothed. The granules are often very short, almost oval, often elongated even to a length of five mikrons.

This species approaches *N. transilis* Allen, differing in its greater tenuity, *much smaller oöspore*, with a different spore-membrane.

Collected in "Shinbashi water" province of Mikawa, Japan; mature in December.

### D.—DESCRIPTION OF NEW VARIETIES AND FORMS OF NITELLA PSEUDOFLABELLATA A. BR. FROM JAPANESE WATERS.

The name was given by A. Braun to the species collected by the Prussian expedition to eastern Asia, 1866. This was formerly confused with *N. flagelliformis* (*N. dispersa* A. Br.) from Java, in Lake Telaga Padenga (in Herb Van den Bosch) very elongated, one to two feet, relatively slender, verticils remote with condensed and tangled leaf-tips, so differing from *N. gracilis*, also blackish-green, flexible. * * * Fertile leaves three- or even four times divided. *The first segment of the leaf distinguished by its length, as long as, or longer than all the divided part of the leaf.* First division into five or six rays, of which one or two may be simple, the remainder further divided; the succeeding segments becoming shorter, but the last again longer. * * * Java: China: Bengal: Borneo, var. *mutila* A. Br.

In his Characeae Nov. Zeland. in Act. Univ. Lund, 1880, Nordstedt publishes a description of a *forma mucosa* and considers it a possible new species.

The elongated first member of the leaf is taken to be a feature of this species; it determines the peculiar aspect of the plant when growing and is quite unique.

NITELLA PSEUDOFLABELLATA IMPERIALIS var. nov.

Plants 20–25 cm. long; stems usually simple, 540 $\mu$ in diam Verticils remote (in the middle portions, 3–4 cm. distant), 12–15 mm. in diam. Leaves 5–8 mm. long: *first segment longest* (*longer than half of the entire leaf*, about 220 $\mu$ in diam.: second segment 102 in diam., about 1200 $\mu$ long; third segment 68 in diam., 540 long; fourth segment 54 in diam., about 600 long (if divided), when the fifth seg. becomes terminal it is about 800 long. The leaf bears three, and frequently four nodes, the *first is sterile usually*, and bears 6–8 rays; the *second* node, fertile, bears 4–5 rays, some of which may be undivided. The *third* node, also fertile, carries 4 or 5 rays, and these are frequently again divided, this *fourth* node bearing three (usually) terminals. The mucro is pronounced, about 27 in diam. at base, by 82–102 long. *Fruit mostly on the second and third nodes* (*not seen on the first* or last nodes); *oögonia isolated*, oöspore black, with seven or eight pronounced ridges, 326 long, 272 broad. Membrane covered with a fine close felt of fine hairs.

The membrane of the spore is most similar to the specimens from Hong Kong, and differ from those from Australia, New Zealand and Java by not having, in addition to the "felt," short spines. In the size of the spores and the character of the membrane it cannot be separated from the Chinese form. These plants from Japan seem to be covered with mucus, which, when dried, causes a glistening appearance to the specimens and glues them tightly to the paper. Collected in Mishitani pond, Fujisato village, prov. Ise, Japan, in September.

While the similarity in the oöspore connects this form with the Chinese form, the Japanese plant is strikingly different in its general habit, and following the advice of Nordstedt I give it a distinct varietal name *imperialis*.

NITELLA PSEUDOFLABELLATA RAMUSCULA var. nov.

Plants about 15 cm. long, diffusely branched, slender, about 400 $\mu$ in diam. Verticils often crowded (the leaves exceeding the length of the internodes), consisting of 8 leaves. The leaves are 5–8 mm. in length; *the first segment longer than half the length of the leaf*, 175–220 in diam. The leaf is usually thrice divided;

the *first node sterile*, bears 6–7 rays; the *second, fertile*, bears 5 rays; the *third* node, *sterile*, bears 2–4 simple, two-celled, terminal rays. *In fertile leaves these terminals are again divided, but rarely.* The *second segment* is shorter than the first, 75–80 in diam.; the third is about the length of the second, 48 in diam. Occasionally a ray of the second, fertile, node is undivided and elongated to equal the length of the terminal rays. The mucro is 20 in diam. at base and 70–80 long. The antheridium is about 125 in diam. *The oögonia are isolated at the second node, only;* the oospore 292 long by 272 broad; with 7–8 faint ridges. The surface of the colored membrane is marked by faint granules, in very low relief, the tops of the ridges are dotted with more prominent granules irregularly disposed, almost as if toothed. From the type this variety differs in its more diffuse habit, the *size of the oöspore and by the markings on its surface.*

The plant was gathered in Shakuhachi pond, Kyoto, Japan.

NITELLA PSEUDOFLABELLATA RAMUSCULA Allen *forma testa-glabra.*

Plants about 30 cm. long, slender, lower verticils remote upper becoming crowded, sparingly branched, stem about 500 $\mu$ in diameter. The verticils consist of 8 leaves. The leaves are thrice divided (very rarely four times divided). The first segments of the leaves are quite long, *about four-fifths of the entire leaf*, 150 in diam. *The first node is sterile*, and consists of 6 or 7 divisions; the *second* node, fertile, has four (usually, rarely 6) divisions, with an occasional undivided terminal ray; the *third* node, sterile, bears three to four terminals. The second segment of the leaf is usually short, 80 in diameter, the third segment is longer than the second about 54 in diameter; the fourth (and fifth, when present) are terminal, 50 in diameter, tapering to the end; the mucro 20 $\mu$ in diameter and 60 long. The antheridia are about 136 in diameter; *the oögonia isolated on the second node only.* The oöspores are 285 long by 272 broad with six faint ridges; the colored membrane of the oöspore is *perfectly smooth.* No indications of mucus have been found on either of the forms in this variety.

Gathered in Mizoro pond, Kyoto, Japan.

### E.—A NEW DIVISION OF THE FLABELLATAE-MACRODACTYLAE SPECIES OF THE DIARTHRODACTYLAE SECTION OF NITELLA.

The species now known, have been classified as (1) *Subflabellatae*, leaves once or twice divided, and (2) *Flabellatae*, twice, thrice or even four times divided. While these divisions cannot be sharply defined, they have served to embrace our known species

and furnish places for many new ones; but a few new forms have come to hand with *leaves many times divided*, with more than four or even six nodes, and it would be convenient to enlarge the bounds to admit them. They cannot be referred to the *brachydactylae* group for they belong to the *macrodactylae*. They do not consort with the forms of *N. pseudoflabellata* A.Br., for the leaves differ in appearance, especially because the first segment of the leaf is not longer than half of the whole divided leaf; so I propose a new subdivision, *Perflabellatae, with leaves 4 or more times divided*. The new arrangement is as follows:

1. *Segments of the second division of the leaf, commonly 2 or 3; primary segments not longer than half the divided leaf* (*N. mucronata* A. Br., *N. expansa* Allen, etc.). § 1. FLABELLATAE.

2. *Secondary segments commonly 4–6; primary segments longer than half the divided leaf* (*N. pseudoflabellata* A. Br. and varieties). § 2. PSEUDOFLABELLATAE.

3. *Secondary segments commonly 4–5; primary segments not longer than half the leaf. Leaf many times divided with 4–6 or more nodes.* § 3. PERFLABELLATAE.

Since the forms of the last section are somewhat similar in habit, have a similar oöspore-membrane, and the first node is usually *sterile* and the *oögonia isolated*, I have placed them under one species, with three varieties as follows:

### NITELLA MULTIPARTITA sp. nov.

Plants elongated, 40 cm. or more, flexible, branching from nearly every verticil. *Verticils* somewhat remote (at centre of stem) of 6–8 leaves which spread from stem. *Leaves* about 2 cm. long. First segment *almost*, but not quite, half the combined length of all the divisions of the leaf; divided *four* or even *six* times; *first node*, bears 6 to 7 segments, *sterile*; second *node*, *fertile*, bears 4 or 5 segments; *third node*, sterile or fertile, bears 4 segments; *fourth node*, bears 4 segments; *fifth node*, bears 3 segments; *sixth node*, bears 2 or 3 terminals. The mucro is 30 $\mu$ in diameter, by 54 long. *The first node is always sterile. The oögonia are isolated* at the second node, rarely also on the third node. The oöspores are 275 to 300 $\mu$ long, and *240* to *290* broad, *with 7 or 8 rounded ridges*; the membrane is evenly granular with about three granules in 5 mikrons.

Collected in "Obitorinoike water," Kyoto, Japan. Mature in July.

The following forms coincide with the type in having leaves with 4 to 6 nodes; the *first node always sterile;* the oögonia isolated at the second and third nodes and the spore-membrane granular.

As regards division of the leaf, the type has six nodes: *f. suberecta* and *f. intermedia* have each five and *f. transiliforma* four. In respect to size the type is more spreading and longer, *f. intermedia* is coarser and *f. transiliforma* the most delicate; as to oöspores *f. intermedia* reaches 306 $\mu$ long by 218 broad, while the others vary within the limits of 240 to 300 long by 224 to 290 broad; the granulation of the spore-membrane is tolerably uniform in all, but faintest in *f. suberecta.*

The mucrones vary from 48 by 15 *intermedia*; 61 by 27 in *suberecta*, 54 by 30 in the type and *f. transiliforma.*

NITELLA MULTIPARTITA Allen, *forma suberecta.*

Plants 15–20 cm. long, rather erect, sparingly branched; stem about 400–500 in diam. *Verticils* spreading, color dull yellowish green, more of the aspect of the forms of *N. pseudoflabellata* than of the bright, clear green of the succeeding form. Leaves bear, 4 or 5 nodes; *first*, with 6 or 7 divisions, *sterile; second*, 4 or 5 divisions fertile; *third*, 4 or 5 divisions, fertile; *fourth*, 3 or 4 divisions, sterile; *fifth* node with 2 or 3 divisions. The segments of the leaves vary, the *first* 2800–3300 long, 122 in diam., the *second* 1600–2600 long, 48–80 in diam.; the *third* 1400–2700 long, 54 in diam.; the *fourth* 500–2000 long, 40 in diam.; the terminals 170–240 long, 34 in diam.; the mucro 20–25 in diam. at base by 50–68 long. The oögonia are isolated; the oöspore 272 long by 245 broad, with seven faint striae, faintly granular.

Collected in Mizoro pond, Kyoto, Japan, in July.

NITELLA MULTIPARTITA Allen, *forma transiliforma.*

Plants about 20 cm. long, erect with about six verticils of bright green leaves. Verticils do not overlap; stem-nodes about 30–40 mm. distant, leaves about 25 mm. long. Stem sparingly branched, as a rule only near the base; stem and branches erect. Leaves slightly spreading, somewhat erect, forming a close verticil about the stem. Stem 400–500 in diameter. Verticil consists of 7 leaves. Leaves 3–4 divided; *first* node 6–7 divisions, *second* 3–4 divisions, *third* 2–3 divisions, *fourth* (when present) 2–3 divisions. The *first segment, less than half the length* of the leaf, 105 in diameter, the *second* 75, the *third* 50, the fourth terminal, 40

in diameter. The mucro 30 in diameter. The mucro 30 in diameter, by 54 long. The oögonia are *isolated* on the *second node only*. Antheridia not seen (plants mature and very fertile); oöspores 275–300 long by 240 broad with 7–8 blunt ridges: membrane of the spore evenly granular (about 3 granules in 5 *u*).

This form, it seems, cannot be separated specifically, though it is an apparent transitory form to N. *transilis* Allen. Like the latter species the leaves are sometimes only 3-divided, and it more resembles *N. transilis* in its fresh, bright green color with close, erect verticils than extreme forms of the type, with a flexuous prostrate habit, of a dull yellowish or brownish green color, with spreading verticils; but the character of the spores, the numerous transition forms and its locality connect it with *N. multipartita*.

The plants were collected in the same locality as the *f. intermedia*.

NITELLA MULTIPARTITA Allen, *forma intermedia*.

This form differs from the type in its more erect habit with less spreading verticils, fewer nodes on the leaves (4 or very rarely, 5); the plants are more slender though more erect, the diameters being as follows: *First* segment 306, *second* 140, *third* 82, *fourth* 61, *fifth* 48; the mucro 15 by 48. The oöspores are of the same size with the same character of ridges and sculpturings on their membranes.

Collected in Kyoto, Japan.

NOTE.—A number of etchings are being made to distribute with the separately printed copies; these will be sent cheerfully to all who may be specially interested in Characeae. T. F. Allen, 3 East 48th Street, New York City.

## New or noteworthy American Grasses.—VIII.

By George V. Nash.

### Andropogon Neo-Mexicanus sp. nov.

Culms from a perennial root, tufted, erect, smooth, glabrous and shining, branched above, 1 metre or less tall, the sterile shoots about one-quarter as long as the culms. Sheaths somewhat compressed, roughish, keeled, at least at the summit, shorter than the internodes; ligule scarious; leaves erect, rough on both surfaces, 8–15 cm. long, 3 mm. or less wide; racemes single, 4–5 cm. long, on long peduncles; internodes of the rachis from one-half to two-thirds as long as the spikelets, densely pilose on the angles with ascending white silky hairs. increasing in length toward the top, those at the apex 3–4 cm. long; spikelets in pairs, one pedicellate and consisting of a single subulate rough short-awned scale 5–6 mm. long, the pedicel about two-thirds as long as the sessile spikelet, clavellate, flattened, densely ciliate on the margins with long white silky ascending hairs; sessile spikelet perfect, a ring of short silky hairs at the base, the outer 2 scales lanceolate, acuminate, equal, glabrous, 8–9 mm. long, the third and fourth scales shorter, hyaline, delicate, cilicate on the margins, the latter deeply and acuminately 2-toothed for about one-third its length and bearing a rough geniculate awn 12–15 mm. long, spiral at the base and loosely twisted above.

Collected by Mr. E. O. Wooton on the White Sands, Doña Ana Co., New Mexico, on August 26, 1897. It belongs to the section *Schizachyrium*, and is related to *A. scoparius*. The profuse white silky longer hairs of the rachis internodes and of the pedicels, giving the racemes much the appearance of young specimens of *A. argyraeus*, furnish the most prominent diagnostic character.

### Panicum Addisonii sp. nov.

Culms 2.5–4 dm. tall, tufted, erect or decumbent at the base, at length much branched, pubescent below with long nearly appressed hairs which decrease in length toward the summit where they are very short; sheaths usually shorter than the internodes, sparingly appressed-pubescent, at least the lower ones; ligule a ring of hairs; leaves erect, lanceolate, thickish, smooth and glabrous on both surfaces, rough on the margins, acuminate, 2.5–8 cm. long, 3–6 mm. wide; panicle ovate to oblong, 2–6 cm. long, its branches spreading or ascending; spikelets broadly obovate, 2

mm. long, the outer 3 scales membranous, the first scale ovate, acute or acutish, about one-half as long as the spikelet, 1-nerved, pubescent, second and third scales 9–11-nerved, densely pubescent with long spreading hairs, the fourth scale chartaceous, almost orbicular, enclosing a palet of equal length and similar texture.

Collected by Mr. E. P. Bicknell in sandy soil at Wildwood, N. J., May 30 and 31, 1897. This most distinct species is allied to *P. neuranthum* and *P. angustifolium*. It affords me great pleasure to name this interesting grass in honor of Hon. Addison Brown, president of the Torrey Botanical Club.

PANICUM COGNATUM Schultes, Mant. 2: 235. 1824.

*Panicum divergens* Muhl. Descr. Gram. 120. 1817. Not H.B.K. 1815.

*Panicum autumnale* Bosc; Spreng. Syst. 1: 320. 1825.

The name of Bosc, hitherto applied so generally to this plant, must give way to that of Schultes, published one year earlier, and based on the *P. divergens* of Muhlenberg, which, in turn, is invalidated by the previous publication of H.B.K. Muhlenberg's description clearly indicates this plant. The earlier name of Walter, *P. nudum*, is accompanied by so poor and inadequate a description that its reference to this plant would be mere assumption. The words of Walter's description, "*foliis caulinis nullis*," would certainly not be descriptive of our plant, in which the culm is quite leafy.

PANICUM EATONI sp. nov.

*Panicum nitidum, forma densiflorum*, Rand & Redfield, Fl. Mt. Desert, 174. 1894.? Not *P. densiflorum* Willd. 1825.

Smooth and glabrous; culms 4–10 dm. tall, erect, at length dichotomously branched and swollen at the nodes; sheaths much shorter than the internodes, usually more or less ciliate on the margins; ligule a ring of long hairs; leaves erect, lanceolate, acuminate, 4–10 cm. long, 3–10 mm. wide; panicle finally long-exserted, dense and contracted, 7–13 cm. long, 3 cm. or less broad, its branches erect-ascending; spikelets oval, about 1.6 mm. long, acutish, the first scale from one-fourth to one-third as long as the spikelet, glabrous, 1-nerved, the second and third scales broadly oval when spread out, 7-nerved, densely pubescent with spreading hairs, the fourth scale chartaceous, at length indurated, about 1.3 mm. long, oval, enclosing a palet of equal length and similar texture.

Along the coast, Maine to New York. I take pleasure in naming this grass for Mr. Alvah A. Eaton, who sent me specimens of it collected by himself at Seabrook, N. H.

PANICUM POLYANTHES Schultes, Mant. 2: 257. 1824.

*Panicum multiflorum* Ell. Bot. S. C. & Ga. 1: 122. 1817. Not Poir. 1816.

*Panicum microcarpon* Muhl. Descr. Gram. 111. June, 1817. Not ex Elliott. Jan. 1817.

Another long familiar name must give place to one of Schultes. Elliott's conception of the *P. microcarpon* of Muhlenberg, as indicated by his description and a specimen from him in the herbarium of Columbia University, was, unfortunately, at variance with that of Muhlenberg himself, so that Elliott's publication of the name, accredited by him to Muhlenberg, invalidated the latter's publication of the same name, rightly applied, some five months later. The *P. multiflorum* of Elliott, on account of Poiret's earlier publication, becomes a homonym. That of Schultes, founded on *P. multiflorum* Ell., is apparently the next available.

PANICUM PSEUDANCEPS sp. nov.

Whole plant, with the exceptions noted below, smooth and glabrous. Culms caespitose, 3–7 dm. tall, erect, slender, much compressed, at length branching at each node; nodes 2 or 3; sheaths compressed and keeled, shorter than the elongated internodes, an external tuft of long hairs on each side at the apex; ligule a ring of hairs 2–3 mm. long; leaves narrowly linear, elongated, conduplicate, at least when dry, 1–3 dm. long, 2–4 mm. wide, long-acuminate at the apex, a little narrowed toward the base, somewhat pilose on the upper surface at and near the base, the basal leaves numerous, about one-half as long as the culm, the culm leaves 2 or 3; panicle long-exserted, narrow, 1–2 dm. long, its branches hispidulous, in 1's–3's, slender, erect, somewhat flexuous, the larger 5–9 cm. long; spikelets numerous, 2.5 mm. long. lanceolate when closed, often with 1–3 bristles at the base, on hispidulous pedicels commonly shorter than themselves, appressed, the first, second and third scales membranous, acute, the first and second a little hispidulous on the keel toward the apex, the first scale about two-fifths as long as the spikelet, broadly triangular-ovate, 3-nerved, the second and third scales equal in length, broadly-ovate when spread out, the second 5–7-nerved, the third 5-nerved and enclosing a 2-nerved hyaline palet somewhat shorter

than itself, the nerves sparingly ciliate, the fourth scale chartaceous, about three-fourths as long as the spikelets, yellowish, elliptic, about 1.75 mm. long, .7 mm. wide, a little pubescent at the acutish apex, enclosing a palet of equal length and similar texture; anthers purple, about 1 mm. long.

Collected by Mr. J. H. Simpson in Florida in 1889, and distributed as *P. anceps* Michx., from which it is markedly distinct by the slenderer culms and leaves, the narrow panicle with its erect and slender branches, and the spikelets but little more than one-half as large.

PANICUM TSUGETORUM sp. nov.

Culms and sheaths pubescent with short appressed hairs intermixed toward the base with longer ones. Culms tufted, 2–4.5 dm. tall, slender, at length much branched and decumbent or prostrate; sheaths shorter than the internodes; ligule a ring of hairs about 1 mm. long; leaves erect or ascending, firm, lanceolate, 5–7-nerved, minutely appressed-pubescent beneath, smooth and glabrous above, or the upper primary leaves sometimes with a few long erect hairs, the primary leaves 4–8 cm. long, 5–8 mm. wide, those on the branches smaller and partly concealing the small panicles; primary panicle broadly ovate, 4–6.5 cm. long, its branches spreading-ascending; spikelets broadly obovate, about 1.8 mm. long, the outer 3 scales membranous, pubescent with short spreading hairs, the first scale broadly ovate, acute, 1-nerved, nearly one-half as long as the spikelet, the second and third scales broadly oval when spread out, 7–9-nerved, the fourth scale chartaceous, oval, about 1.5 mm. long, enclosing a palet of similar texture and equal length.

Type material collected by the writer in the Hemlock Grove, New York Botanical Garden, on dry soil, June 22, 1896, no. 287. The later and much branched condition was secured at the same spot on July 20 and August 20 of the same year, Nos. 417 and 483 respectively.

ARISTIDA LANOSA Muhl., Descr. Gram. 174. June 12, 1817.

*Aristida lanata* Poir. in Lam. Encycl. Suppl. 1:453. 1810. Not Forsk. 1775.

*Chaetaria gossypina* Bosc; Beauv. Agrost. 30. 1812. Name only.

*Chaetaria gossypina* Beauv. R. & S. Syst. 2:391. July 31, 1817.

The date of the copyright of Muhlenberg's work is June 12, while that of the preface of the second volume of Roemer and Schultes' Systema is July 31, both in the same year. Muhlenberg's name, therefore, takes precedence of that of Beauvois. The specific name of *gossypina*, credited to Bosc by Beauvois under the generic name of *Chaetaria*, although occurring in a work published five years previous to that of Muhlenberg, is not available, as no description or synonymy are given by Beauvois, the name being merely cited as a manuscript name of Bosc.

SPOROBOLUS NEALLEYI Vasey, Contr. U. S. Nat. Herb, 3: 61. 1892.

As the description given by Dr. Vasey, at the place above cited, is rather short, and its efficiency being further impaired by the confusion existing in the last lines, owing to the omission of some words, another and more complete description seems desirable. The following is, therefore, appended, drawn from the material to which the writer has had access:

Plant grayish green; culms from a perennial root, densely tufted, smooth and glabrous, erect, slender, 1.5–5 dm. tall, the sterile shoots about one-half as long as the culms; sheaths shorter than the internodes, a ring of long hairs at the apex, the lower sheaths usually more or less villous, at least the uppermost one elongated and glabrous; ligule a ring of long hairs; leaves spreading, rigid, flat, or involute in drying, rough above, smooth beneath, 4–10 cm. long, 1.5 mm. or less wide; panicle at first included, at length exserted, open, 3–8 cm. long, ovate, its smooth branches spreading and slender; spikelets about 2 mm. long, often purplish, on hispidulous pedicels; empty scales narrow and acuminate, the first about one-half as long as the second which is hispidulous on the mid-nerve toward the apex and about four-fifths as long as the acute third; palet acute, about as long as the scale.

During the past summer Mr. E. O. Wooton secured this grass from another locality, it being previously known from Texas only. Mr. Wooton collected it on the White Sands, Doña Ana Co., New Mexico, July 17, 1897. No. 160.

BLEPHARONEURON gen. nov.

A tufted perennial grass with simple culms, long leaves and a terminal loose and open panicle. Spikelets 1-flowered, the rachilla articulated above the empty scales, the pedicels filiform, flexuous, abruptly and much thickened at the apex; scales 3, membranous, the outer 2 empty, 1-nerved, acute, smooth and glabrous, the first narrower and shorter than the second, the third scale equalling or a little longer than the second, entire or minutely 2-toothed at the obtuse apex, 3-nerved, the nerves densely pilose, excepting at the apex, with long ascending silky hairs, the midnerve usually excurrent in a short point; palet as long as but narrower than the scale, acuminate, 2-nerved, densely pilose on and between the nerves, with ascending silky hairs; stamens 3; styles 2, slightly or not at all united at the base; stigmas plumose.

A monotypic genus of Mexico and the southwestern United States, based on the *Vilfa tricholepis* of Torrey. This, in recent years, has been considered a member of the genus *Sporobolus*, but its inclusion therein necessitates the extension of the limits of that genus to such a degree that the result thus obtained neither serves the use of expediency, nor that far more vital and important factor in systematic work, the treatment of genera from the standpoint of natural and evident groups. I would, therefore, propose the above name for this interesting grass, the densely pilose nerves of the flowering scale and palet suggesting it. The plant has not the appearance of a *Sporobolus*, and the densely pilose character of the nerves, above alluded to, abundantly distinguishes it from that genus, which, even from its present conception, appears to contain species too widely separated in essential characters.

BLEPHARONEURON TRICHOLEPIS (Torr.).

*Vilfa tricholepis* Torr. Pacif. R. R. Rep. **4**: 155. 1857.

*Sporobolus tricholepis* Torr.; Coult. Man. Rocky Mt. Bot. 411. 1885.

SPOROBOLUS GIGANTEUS sp. nov.

Plant smooth and glabrous. Culms somewhat tufted, stout, erect from a usually decumbent base, 1–1.5 metres tall, about 1 cm. thick at the base; sheaths crowded and overlapping, striate, loose, villous-ciliate on the margins, a tuft of villous hairs on each side at the summit, the uppermost sheath elongated and enclosing

the greater part of the panicle; ligule a ring of very short hairs; leaves erect, 2–5 dm. long, 1 cm. or less wide at the base, attenuated into a long slender point; panicle yellowish white, shining, strict, rigid, 3–5 dm. long, 6–10 mm. thick, the greater portion included in the sheath, its branches appressed; spikelets numerous, 3 mm. long, the scales narrow, acuminate, 1-nerved, the nerves hispidulous toward the apex, the first scale one-half as long as the second which equals or slightly exceeds the third; palet a little shorter than the scale, acute; grain oval, about 1.5 mm. long.

Type collected by Mr. E. O. Wooton on the White Sands, Doña Ana Co., New Mexico, on August 26, 1897. No. 394. Also secured on adobe soil at Mesilla, on June 22, of the same year. No. 582.

Mr. Wooton informs me that the two varieties, *flexuosus* and *strictus* of *S. cryptandrus*, occur on the White Sands with this, the largest species of the genus in the country, and that they appear perfectly distinct, no intergrading forms occurring.

## On an abnormal cone in the Douglas Spruce, Pseudotsuga mucronata.

By Francis E. Lloyd.

(With Plate 327.)

While studying a number of specimens of this species which had grown in a grove at Forest Grove, Oregon, the writer found a tree about 40 years old in which the leader of the year before had produced in its upper portion a cone which was abnormal both in its position and structure.

Normal cones are produced from lateral buds at the ends of twigs in the middle and lower portions of the tree. During the few days while pollination is in progress they stand upright. After pollination, however, they exhibit a downward movement till the position is entirely reversed and the cones hang down, in doing which they have assumed the position characteristic of the spruces, to which the Douglas Spruce is closely allied.

The normal cones are from 7 to 10 cm. in length and when mature and dry the scales spread to make a width of 4 to 4.5 cm. The ovuliferous scales are orbicular in outline, and are concave above. Each scale is subtended by a so-called bract, which is nothing more or less than the leaf which subtends the scale, but which differs from the ordinary foliage leaves in being expanded laterally. The character of the lateral expansion is of great interest,for we have here a structure which strongly suggests a stipular affair. So far as the topography of the bract and the ontogenetic series found in the female shoot offer evidence, it would seem that we are justified in so regarding it. At the base of the cone the lateral expansions are quite small and at the base of the bract. In ascending the cone the blade gets smaller gradually till it becomes at the top a mere point on the tip of the now triangular scale-like bracts which are quite primitive in character. That these expansions are, strictly speaking, stipules may be objected to on the ground that there is not developed therein any vascular tissue, for it has been held that the development of such tissue is a

constant feature of stipular outgrowths.* May not the leaves in conifers be regarded as exceptional, however, on account of their peculiarities in the distribution of the vascular tissue, and their manner of growth? If, however, the use of the term stipule entails the idea that the causes underlying the origin of the lateral expansion of the bracts in *Pseudotsuga* and the true stipule of the Angiosperms are the same, we have here a more serious objection and one which cannot be put away without further study. In *Abies* such an expansion of the bracts takes place, and certain features in the cones of this genus and of *Pseudotsuga* indicate that the pressure of the scales upon the bracts may account for it. This explanation is suggested by a consideration of the maturing cones of *Pseudotsuga*. During the growth of the cone after fertilization, the pressure of the scales upon the bracts, which continue to grow at their bases, increases and they become narrower and more constricted wherever this increased pressure is brought to bear upon them. This is, of course, in their lower parts which are not exserted.

As to the function of these bracts it may be said that, while they are undoubtedly assimilative to some degree both before and after anthesis, they serve more especially as guides to lead the pollen to the micropyles during pollination. In this regard, therefore, they are far different from the stipules of angiosperms.

The transverse section of the upper or laminar portion of a bract shows that the bracts conform to the leaves in their plan of structure, but do not develop any supporting cells in the interior. This is correlated with the fact that the bracts do not support themselves in the more or less horizontal position in which the ordinary leaves are placed, but simply hang down. The parenchyma, moreover, consists of spherical cells and there is no well defined palisade tissue nor stellate cells.

A similar section taken through the stipular region shows the same features, and shows in addition the character of the lateral expansion, which consists of a thin extension of the spherical parenchyma cells bounded above and below by the epidermis. The endoderm is here but poorly developed, while in the lamina

* "The Nature and Origin of Stipules," A. A. Tyler, Ann. N. Y. Acad. Sci., 10: 1–49. 1897.

the sheath is continuous and fairly well formed. The foliage leaves, on the other hand, have a strongly developed hypoderm which is absent only in the regions in which are found the stomata.

The abnormal cone, which, as has been stated, was produced in the upper portion of the leader, is 45 mm. long, and is made up of seminiferous scales subtended by slightly modified leaves. The scales in the lower portion of the cone are somewhat irregular but differ only in a minor degree from those in the normal cone, while as we pass upwards they become smaller and somewhat irregular and scattered. That they become scattered is due to the failure of the scales to develop in some cases, although a close examination of the axils of the leaves in these cases will discover small structures of bud-like appearance. That these structures are the morphological equivalents of buds, their origin and position strongly attest. That they would, upon further development, have become ovuliferous scales is equally sure.

There can be no doubt, therefore, that the scales are developed from the axils and not from the upper faces of the leaves. The scale is, therefore, not "an appendage, a ventral excrescence, a ligule if it may be so called, of a leaf,"* but rather a reduced and modified branch. In support of the view, first advanced by A. Braun, that the scale represents two connate leaves, it may be said that the irregularity of the scales, when such irregularity occurs, seems to be due in each case to unequal growth of the two halves. This is what would be likely to happen under a slight irregularity of nutrition. Furthermore, the line of connation can be traced in one case by a ridge along the inside of the scale.

In several of the scales ovules were produced, but these failed of fertilization, and so no seeds were matured.

The scales are subtended by leaves which differ from the normal leaves in having acute apices and in some cases in being slightly expanded in the lateral portions. In the production of these characters, however, a strong attempt has been made to copy in every respect the normal cone in which the leaves are modified in just this way but to a greater degree. The amount of lateral expansion undegone by the various cone-leaves is greatest

* Eichler: Monatsber. d. k. Acad. d. Wiss. Berlin, 1881.

in the thickest part of the cone, paralleling in this regard the case of the normal cone.

Below the base of the cone for the distance of 1 cm. are found foliage leaves with acute apices (Fig. 15). Further still below, the leaves approach more closely to the normal shape (Fig. 14), but still differ in having somewhat acute apices (Fig. 20).

The leader involved is bent so as to suggest that some accident overtook it during its growth. The bracts are quite sharply bent at their tips (Fig. 12), as if they too had shared the leader's misfortune. At the top of the leader were produced normal terminal and lateral buds which developed in the usual way the following spring.

We have, then, in the structure upon which the above description is based the result of the sudden assumption of the sporophyllary function by the tissue of a normally strictly negative shoot. We have here to do with the question which has grown out of Bower's * view that foliage leaves are secondary structures produced by the sterilization of the sphorophylls.

Bower has been followed by Atkinson,† who has attacked the problem from the point of view of the experimental morphologist, and has discussed the relation of the sporophyte to nutrition. Professor Atkinson's convictions in the matter are based to a considerable extent upon experimental work upon two species of *Onoclea*, in which the sporogenous leaves were made to take on the assimilative condition by cutting away the earlier and normally assimilative leaves and thus robbing the plants of food which they would otherwise get. The condition thus induced is compared directly with the probable conditions under which the sporophyte was made to assume more and more the assimilative function when the change from water to dry land was one with which the gametophyte was unable to cope.

The conversion of a vegetative shoot in a conifer to a sporophyll-bearing shoot is of peculiar interest in this connection in that it must have some bearing upon the view propounded by Bower. In the coniferae only a few lateral buds are normally produced

* Bower: "A Theory of the Strobilus in Archegoniate Plants." Ann. Bot., 8, 343. 1894.

†Atkinson: Woods Holl Biol. Lect. 1895. Am. Nat. 30: My. 1896.

near the ends of the vegetative shoots. In the pistillate shoots, however, the axillary buds, throughout the greater part of its length, are developed into the ovuliferous scales. The production of these scales, therefore, upon a shoot normally vegetative would seem to be due to excess of nutrition, in response to some sort of irritation. Why the axillary buds thus forced into growth should not become simply vegetative, instead of spore-bearing, may be due to inherited tendencies, and if so, we have here a case of atavism, a return to a condition during times long gone by, when the sporophyte was chiefly or altogether sporogenous. Unfortunately for this view, there is no little difficulty to be encountered in harmonizing the facts derived from the study of teratological conditions found in the angiosperms, as, for example, the change from carpel to foliage leaf. All that we can assert at present is the interchangeable character of plant structures.

**Explanation of Plate 327.**

FIGS. 1–11 inclusive. A series of bracts from the pistillate shoot.

FIG. 1. Leaf from pistillate shoot immediately below the cone.

FIG. 2. Bract from base of cone.

FIG. 11. Bract from tip of cone.

FIG. 12. Lateral view of the apex of a bract from the abnormal cone.

FIG. 13. Normal leaf, × 3/2.

FIG. 14. Leaf from the leader which produced the abnormal cone.

FIG. 15. Leaf taken from the leader immediately below the abnormal cone.

FIG. 16. Leaf subtending a scale in the abnormal cone showing the maximum degree of lateral expansion attained.

FIG. 17. A small portion of the leader bearing a leaf and, in its axil, a reduced scale, × 15/1, *s*, scale; *l*, leaf; *c*, leaf-cushion.

FIG. 18. Longitudinal section of same, × 20/1 about. Drawn with camera lucida.

FIG. 19. Tip of normal leaf, × 6/1.

FIG. 20. Tip of leaf from leader in question, × 6/1.

FIG. 21. An abnormal, asymmetrically developed scale showing discrepancy of growth between the two sides, × 3/2.

## Porella once more.

I. By Auguste Le Jolis.

Mr. Marshall A. Howe, having been so courteous as to send me a copy of his recent paper on "The North American Species of Porella," reprinted from the Bulletin of the Torrey Botanical Club, November, 1897, in which I am somewhat criticised, I beg leave to present a brief reply in the same Bulletin.

In his paper, Mr. Marshall A. Howe concludes, from the identification of the specimen in the Dillenian herbarium, that the name *Porella* must "stand as the name of the genus." I cannot agree with such a deduction. If, owing to that identification, the *specific* question has long ago been resolved, the *generic* question is quite another thing, and it stands thus: Is the Dillenian lycopodiaceous genus *Porella* a previous equivalent to the modern genus *Madotheca?* Is its generic character the true generic character of *Madotheca?* That is the question.

Dillen has established his genus on "naked antheraceous capsules, without operculum or pedicel, dehiscing by several pores through the sides, and emitting a farinaceous powder," whence the name *Porella*. Consequently, any plant which does not bear such capsules, with several farinaceous pores, cannot be entered in the genus *Porella* nor can be entitled to bear that significant name *Porella*.

It is to be considered that Dillen, after ranging his *Porella* among the lycopods, describes and figures *another specimen of the same species* in his genus "Lichenastrum" (=*Jungermannia*), under the name "Lichenastrum filicinum pennatum" (Hist. Musc., 495. *pl. 71. f. 25*), the specimen of which, in the Dillenian herbarium, according to the opinion of S. O. Lindberg and Prof. S. H. Vines, certainly belongs to the same species as the specimen of "Porella pinnata." In fact, *Porella* was a mere blunder of Dillen, and a name which is the expression of such a gross blunder cannot stand as the name of a modern scientific genus.

I may add that Mr. Marshall A. Howe seems to have somewhat misunderstood my papers on *Porella*, for I have never written

"that Dickson considered his *Jungermannia Porella* to be different from the *Porella* of Dillenius"; on the contrary, I have said that Dickson, having compared his *Jungermannia* with the specimen of Dillen, did find out that the two plants were alike.

I may also give notice that my own copy of "Dillenii Historia Muscorum" is the editio princeps of 1741, and that I have not seen the reprints of 1763 and 1811, to which Mr. Marshall A. Howe has only had access; I am then ignorant if those reprints or reproductions of the plates are quite identical with the standard original edition.

As to the expression "Porella pinnata L.," it seems most unreasonable thus to point out Linné as the author of the genus and species, when he himself declares that he has never seen the plant, gives no description of it, and quotes only the Dillenian name, affixing to it the sign †, meaning that the plant is thoroughly unknown to him.

CHERBOURG, January 9, 1898.

II. BY MARSHALL A. HOWE.

While the author of the paper which M. Auguste Le Jolis has honored with the foregoing comments believes that the chief end of botanical science is the study of plants rather than of plant-names, a sentiment which his well known critic would heartily endorse, he nevertheless cannot well wholly evade the puzzles of nomenclature and is obliged to admit that their correct solution is a matter of considerable importance. In regard to the principal point referred to by M. Le Jolis—the question of equivalence of *Porella* and *Madotheca*—the only inquiry that needs to be made by one who follows the code adopted at Rochester in 1892 by the Botanical Club of the American Association for the Advancement of Science is whether the species to which these names were originally applied are congeneric. That these species are thus congeneric has, I think, been sufficiently demonstrated, and seems not now to be contested even by M. Le Jolis. The French savant's chief objections to the use of the name *Porella* are in accord with the sentiments of the Paris Code of 1867, which is accepted by the great majority of American systematic botanists of to-day only with certain modifications. The practical application

of the Paris code, with its provisions for various exceptions to the law of priority, led to such diversities of usage in matters of nomenclature, especially, perhaps, in the Phanerogamia, that working systematists in various parts of the world have thought to secure greater stability of nomenclature in the end by closer adherence to the priority principle, even though this principle is not so easy to apply as to formulate and unfortunately calls for the disappearance of many familiar names. Practically the sole limitation imposed on priority by the Rochester code is the initial date 1753. Three of the articles of this code are:

I. *The Law of Priority*—Priority of publication is to be regarded as the fundamental principle of botanical nomenclature.

II. *Beginning of Botanical Nomenclature.*—The botanical nomenclature of both genera and species is to begin with the publication of the first edition of Linnaeus' "Species Plantarum," in 1753.

* * * * * * *

V. *Publication of Genera.*—Publication of a genus consists only (1) In the distribution of a printed description of the genus named; (2) In the publication of the name of the genus and the citation of one or more previously published species as examples or types of the genus, with or without diagnosis.

In accordance with the spirit of the second part of Article V., I would, therefore, with Lindberg, Spruce, Carrington, Pearson, Mitten, Arnell, Underwood, Evans, Kaalaas, Rossetti, and others, (at times, also, Stephani, Massalongo and Schiffner), take the ground that *Porella* is not a *nomen nudum* with Linnaeus. It is true that he never saw the plant, but he did give it a place among his genera and species, and referred to the figure and description given by Dillenius, and this saves the *Porella* of Linnaeus from being a "bare name."

It is incontestable that Dillenius made serious errors in his interpretation of the characters of the plant and that these are embalmed in the name *Porella*. Yet the meaning of his description and figures was sufficiently clear to give Dickson (on receiving what was perhaps the first specimen of the plant thereafter sent from America to Europe) ground to "suspect" that his plant and that of Dillenius were "the same"—which he easily proved to be the case by comparing the specimens. And it seems to me that his figures and description were sufficiently clear to have enabled others besides

Dickson to "suspect." But "*Porella*" was from America. If it had been attributed to Europe (where, also, *Porella pinnata* is said to occur) the botanists of the time would, it may be, have been more curious to know what the genus which the distinguished Linnaeus had thought worthy of being copied into his works really was; would, perhaps, after Dickson's identification and corrections, have written it as a synonym of *Jungermania*, and, possibly, on the final dismemberment of the latter group, would have assigned it its proper place with the necessary emendations. But "priority" was not so much in vogue in those days, though, in general, there was great respect for the Linnaean names. As it was, however, Nees (in Naturgesch. Eur. Leberm.) recognized "Porella Dill." as a synonym of his *Madotheca Porella*.

"*Madotheca*," itself, in its original form, has little to boast of over *Porella*. Dumortier, in his Commentationes Botanicae (1822, p. 111), writes:

MADOTHECA

Colesula ore coarctato; theca quadridentata; elaters vagi circumdati.

Platiphylla Laevigata
Thuya

*Not an essential character of the "genus" is touched upon*,* and

* Greatly superior to this is S. F. Gray's diagnosis of the equivalent *Cavendishia* published one year earlier (Nat. Arr. Brit. Pl. 1: 689. 1821). It reads as follows:

"XVIII. 332. CAVENDISHIA. *Cavendish.*

"Monoicous. MALE. *Anthers* spherical, pedicelled, solitary, in the axillae of the perichaetial leaves. FEM. *Calyx* lateral, ovate, narrow at bottom, compressed, becoming cylindrical; mouth truncated, serrate, slit on one side; *peduncle* short, not jointed; *capsule* spherical, seemingly 4-valved; valves upright, irregularly networked; *seed* roundish; elaters membranaceous, tubular; helices double, loosely twisted; *leaves* 2-rowed, 2-cut, segments unequal, conduplicate.

"1. *Cavendishia platyphylla.* *Broad-leaved cavendish.*

"*Stem* lying down, bipinnately branched; *leaves*, upper lobe roundish, ovate, scarcely cut; lower lobe and *stipules* strap-like, uncut.

"*Lichenastrum arboris vitae facie, foliis minus rotundis*, Dillen Musc. 72, 32.

"*Jungermannia platyphylla*, Lin. S. P. 1600; Eng. Bot. 798; Hooker Jung. 40.

"*Jungermannia cupressiformis* β, Lamarck Encyl. 3, 383."

[Two varieties, β *major* and γ *thujaeformis*, are also described, and the habitat given.]

"2. *Cavendishia laevigata.* *Smooth cavendish.*

"*Stem* lying down; branches irregularly pinnate; *leaves* 2-rowed, unequally 2-

the identity of the group is recognizable only by the familiar form of the three specific names that he mentions.* He does not even state where these names may be found in the works of his predecessors. Moreover, "Madotheca" is placed in his Tribe I., the Lejeuniaceae, the members of which have the following character: "Theca pellucida univalvis quadridentata." But the "theca" of his *Madotheca* is no more pellucid than in some members of his Tribe II. (Jungermanniaceae), in which this organ is said to be coriaceous, the theca is not *univalved*, and it is not quadridentate in any modern sense of the term. It is true that Dumortier improved considerably upon this diagnosis nine years later, yet the name owes its worth chiefly to the emendations of Nees von Esenbeck; and *Porella*, it must be confessed, owes very much to the emendations of S. O. Lindberg.

It cannot be disputed that the name *Porella* was given through a wrong understanding of some of the characters of the plant. Yet if generic or specific names are to be rejected simply because they are inappropriate or embody misconceptions, where are we to stop? Under this method of procedure, every writer may consult his own tastes and caprices as to the aptness of a name, as the past history of taxonomy has abundantly demonstrated. Commonly used and "classical" generic names† that were founded on wrong ideas or that are false and misleading except

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lobed, thorny-toothed; upper lobes largest, rounded ovate, lower strap-shape, flat pressed close; *stipules* oblong, 4-sided, thorny-toothed.

"*Jungermannia laevigata* Schrad. Samml. 2, 6; Hooker Jung. 35.

"On the ground in mountain woods."

If this hepaticological work of S. F. Gray was mere compilation, as has been alleged, it was a much more intelligible compilation, on the whole, than that of Dumortier in his Commentationes Botanicae. About the only part of the above description that can be considered positively wrong is the attributing of a monoicous character to the genus, while both the species on which it is based are now uniformly described by systematists as dioicous. Yet a modern morphological investigator writes: "Les Madotheca sont monoïques, on trouve les deux espèces d'organes de reproduction dans la même inflorescence (Fig. 52, Pl. IX.)!" [L.-A. Gayet, L' Archegone chez les Muscinées, Ann. Sci. Nat. Bot. VIII. 3: 199. 1897.]

BELLINCINIA and ANTOIRIA of Raddi are also older than *Madotheca* and no one doubts their meaning.

* See remarks of Richard Spruce on Dumortier's genera. [On Cephalozia, 1.]

† EULOPHUS Nutt. (*ευ, well*, and *λοφος, a crest*) "is not well applied," says Asa Gray, "to a plant with no crest at all." Yet the name appears in De Candolle's

for the original species are not far to seek and from these we may pass to any shade of inappropriateness.

The identity of the species to which Linnaeus applied the binomial *Porella pinnata*, without ever seeing it himself, will, I think, hardly be called in question, and knowing the species we also know its genus, even though the generic diagnosis can never be completed and properly restricted until all the species of the group in the world are accurately known. Knowing the single species to which the generic name *Porella* was applied by Dillenius (copied by Linnaeus), and knowing, too, by tradition or otherwise, the three species to which Dumortier in 1822 (with an unmeaning 8-word diagnosis) applied the generic name *Madotheca*, we are agreed that the four species are congeneric. Our main point of difference, then, is over the question whether the Dillenian and Linnaean name, which has claimed a goodly number of partisans in recent years, shall stand, or the name introduced by Dumortier some seventy or eighty years later—a question concerning which men equally honest, equally thorough-going and equally "scientific," may doubtless differ. Personally, believing that a rigorous application of the priority principle gives promise of the best final solution of our nomenclatural difficulties, I cannot do otherwise than to adhere to the name *Porella*.

If Dillenius had *Porella pinnata* also under "Lichenastrum filicinum pennatum" on a later page of the Historia, as seems well attested, this fact would have no special bearing on the point at issue, for "Lichenastrum" does not appear as a genus on the pages of Linnaeus; and Linnaeus, not Dillenius, is our starting

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Prodromus and is generally used.

GALAX L. "Name from γαλα, *milk*, of no conceivable application to the plant" [Asa Gray]. Yet it is adopted in Engler and Prantl, Nat. Pfl. Fam., and is in general use; and the only known species is *Galax aphylla* L., of which Linnaeus never wrote *one word* of his own in the way of *specific* description. Moreover, the *leaves* of *Galax aphylla* are the most conspicuous part of the plant. In this case we have a specific name that is positively *false* ("a mere blunder" of Linnaeus!), a generic name that is certainly misleading, and a species which Linnaeus never formally defined, yet "Galax aphylla L." is maintained by every one!

CHAMAELIRIUM Willd. (Name from χαμαι, *on the ground*, and λειριον, *lily*.) Plant 1½–4 feet tall. "Genus founded on a dwarf undeveloped specimen." In Engler and Prantl, Nat. Pfl. Fam., and generally used.

This list of more or less grossly inappropriate names might be widely extended.

point, even though we are often obliged to go back of Linnaeus for the proper understanding of his genera and species. The "Lichenastrum filicinum pennatum" is said to have come from Patagonia, one quarter of the earth's circumference from Pennsylvania, the habitat of *Porella pinnata*, and if Dillenius classified it under quite a different head it is perhaps only additional proof that the illustrious cryptogamist shared with other mortals the liability to err.

M. Le Jolis says that, "As to the expression '*Porella pinnata L.*' it seems most unreasonable thus to point out Linné as the author of the genus and species when he himself declares that he has never seen the plant, gives no description of it and quotes only the Dillenian name," etc. Yet hepaticologists, almost without exception, now write "*Targionia hypophylla L.*," to which Linnaeus, so far as I am able to discover, never gave *one word* of his own in the way of *specific description*. But *Targionia hypophylla L.* cannot fairly be called a *nomen nudum*, for he made his meaning clear by citing descriptions and figures in Micheli and other authors who were more familiar with the plant than he. Writing "*Targionia hypophylla L.*," then, simply signifies that Linnaeus was the first to combine the specific name *hypophylla* with Micheli's generic name *Targionia*. So, writing "*Porella pinnata L.*" means simply that Linneaus was the first to combine the specific name *pinnata* with Dillen's generic name *Porella*. It would certainly be most unreasonable and unjust, in a formal systematic work, to write "Targionia L." over a generic diagnosis without accompanying it by "Ex Michelio," inasmuch as Micheli was its real author; under the same circumstances, *Porella* should be followed by "L. Ex Dill." as I have written it in the paper to which M. Le Jolis refers. But that the day may sometime come when there shall be sufficient uniformity in plant nomenclature to justify the dropping of the name of the author entirely in all ordinary use is a thing to be hoped for.

M. Le Jolis is to be congratulated on his possession of the "editio princeps" of the Historia Muscorum. We imagine, however, that the essential points in the controversy are covered equally well by the Edinburgh reprint of 1811, together with the abridged edition of 1763.

M. Auguste Le Jolis says: "I may add that Mr. Marshall A. Howe seems to have somewhat misunderstood my papers on *Porella*, for I have never written 'that Dickson considered his *Jungermannia Porella* to be different from the *Porella* of Dillenius'; on the contrary, I have said that Dickson, having compared his *Jungermannia* with the specimen of Dillen, did find out that the two plants were alike." M. Auguste Le Jolis would have given a somewhat more accurate idea of what I really wrote if his quotation marks had been a little more widely inclusive. My statement was:* "Mr. James Dickson was the first to detect that the *Porella* of Dillenius belonged to the Jungermaniaceae, and it may be worth while to quote his narrative of the circumstances, especially as M. Le Jolis has somewhat recently† given the impression that the discovery was wholly a chance affair and also that Dickson considered his *Jungermannia Porella* to be different from the *Porella* of Dillenius." The last half of this "impression" of mine was derived from the following words of M. Le Jolis:‡ "Il [Dickson] donne ensuite une description et une figure de cette espèce, *la considérant avec raison comme nouvelle* § et en souvenir du nom de Dillenius la nomme *Jungermannia Porella*." If M. Le Jolis meant by "nouvelle" simply that the species had not hitherto been entered in the genus *Jungermania* we owe him an apology. He should be allowed the privilege of interpreting his own words. It is true that in the preceding lines (*l. c.*) he had stated that Dickson "reconnut que les deux plantes étaient semblables." But "semblable" seems to a foreigner to have a slightly dubious meaning, especially in connection with such words as cited above, and, I suspect, does not exhaust the possibilities of the French language for expressing Dickson's complete conviction as to the specific identity of the two specimens.

Mr. Dickson himself says on this point: "Upon the most careful examination, I found my *Jungermannia* to agree exactly with his *Porella*, but could find no fructification upon his specimen. As I have no doubt that my *Jungermannia* and his *Porella*

* Bull. Torr. Bot. Club, 24: 513. 1897.

† Rev. Bryol. 19: 99. 1892.

‡ Rev. Bryol. 19: 99, line 33. 1892.

§ The italics are ours.

are one and the same plant, I shall next endeavor to trace how Dillenius has fallen into this error." Dickson's identification has been repeated by competent critics several times since, and one might go so far as to infer from his latest statements that even M. Auguste Le Jolis no longer entertains doubts as to what *Porella* really was, but perhaps I misunderstand him.

M. Le Jolis has often in his various papers on the nomenclature of the Hepaticae referred with becoming deference to the opinions of one of the great masters of hepaticology—Dr. Richard Spruce. Below, however, are words of Dr. Spruce (relative to the use of S. F. Gray's generic names) which, so far as I know, have never been quoted by M. Le Jolis: "The dogma of the absolute sanctity of the earliest generic or specific name is a comparatively modern invention. That it is, generally speaking, worthy of adoption there can be no doubt, not so much as an act of justice or courtesy to authors as for the sake of settling the synonymy, and out of a multitude of names to have some certain guide to the selection of the only one needed. But if it were claimed solely as a *right* of authors, it might safely be asked if there were no *duties* the fulfillment of which should entitle an author—or his successors for him—to prefer that claim. That there are such duties is so plain that I need not stay to point them out. *For the present, however, it seems that, whether the duties have been fulfilled or not, the right of preference of the most ancient name is the absolute rule of botanists.*" *

COLUMBIA UNIVERSITY, NEW YORK, January 26, 1898.

* Rev. Bryol. 8: 90. 1881. The italics of the last sentence are ours.

# Two new Grasses from Van Cortlandt Park, New York City.

By Eugene P. Bicknell.

(Plates 328, 329.)

## Savastana Nashii.

Perennial from slender creeping rootstocks; culm simple, erect, 6–10 dm. tall, smooth and glabrous; sheaths smooth and glabrous, closely embracing the culms, all, or all but the upper one, arising from near the base of the culm, elongated, the upper one sometimes 30 cm. long, much overlapping, the exposed interspaces 5–15 cm. in length; principal leaves 5–8, ascending or erect, narrowly linear from a narrowed base, tapering to an attenuate apex, 3–5 mm. wide, 1–3 dm. long, much longer than the interspaces, the penultimate leaf usually longest, those below gradually shorter, one or more basal ones abruptly much reduced and nearly bladeless; lower surface of the leaf-blades bright shining green, upper surface dull green and glabrous or with some obscure pubescence, the rough edges scarcely involute when dry except at the scabrous apex; lower leaves at flowering-time becoming dry and narrowly involute; ligule from 2 mm. long on the lower leaves to 7 mm. long on the uppermost, the margins becoming ciliate, pubescent; panicle slenderly long-exserted, very loose and open-often one-sided, 1.3–4.8 dm. long, the very delicate hairlike branches simple or remotely short-branched, 8–23 cm. long, in about four distant main pairs below the drooping top of the panicle, the lower pairs 5–8 cm. apart, all loosely spreading or ascending and bearing the spikelets above the middle in delicate moniliform pendulous sprays; spikelets 5–8 mm. long, 1.6–3 mm. wide; lower glumes somewhat unequal, the inner surpassing the outer 1–1.5 mm., delicately membranous and silvery hyaline, 3-nerved, the outer nerves often nearly obsolete on the narrower first glume, the second glume 3 mm. wide, tapering from about the middle to an attenuate apex; flowering-glumes about 5 mm. long, narrower and more gradually acuminate than in *S. odorata*, 5-nerved, chartaceous, chestnut-brown, often obscurely puberulent-roughened, minutely awned from the acuminate bifid apex; palets cleft at the apex into slender teeth; fertile flower hairy-pubescent at the top of the minutely awned outer scale; each flower with a minute tuft of hairs at its base; sterile culms similar to those of *S. odorata* but taller, its more numerous leaves longer and more acuminate. (Plate 328.)

Discovered in Van Cortlandt Park, New York City, July 11, 1897, freshly in flower and growing plentifully about the weedy border of an alder thicket close to a brackish marsh. Near by was

an abundant growth of *Savastana odorata*, its remaining fertile culms having the leaves and panicle dried and brown. *S. Nashii* was still in flower at the same spot on August 8th and withering specimens were collected September 18th.

This grass, although closely related to *Savastana odorata* (L.) Scribn., differs conspicuously in various characters and presents a widely different appearance. Its fertile culms are much taller with more numerous and very much longer leaves, which are narrower, especially at the throat, and with closer sheaths, while the panicle is larger and incomparably looser. The spikelets are narrower and slightly longer, their very delicately membranous outer glumes more unequal, less distinctly nerved, narrower and more gradually acuminate with their tips mostly straight at maturity instead of often outcurved as in *S. odorata;* the flowering glumes are narrower and more acuminate and often more distinctly awned and ciliate.

Not the least noteworthy thing in regard to this grass as compared with *S. odorata*, is its much later flowering period—July to September; *S. odorata*, the earliest flowering of our native grasses, blooming from the middle of April till June.

I take pleasure in naming this interesting grass for Mr. George V. Nash, with whom I was enabled to make a study of it in the field a few days after its first discovery.

### CHAETOCHLOA VERSICOLOR.

Perennial from an intricately short-branched and somewhat stoloniferous rootstock; not at all or but slightly tufted; culm 6–12 dm. high, ascending or suberect from an assurgent base, slender, often somewhat zigzag below, simple or bearing a few ascending branches; leaves long and narrow, 1–3.5 dm. long, 2–6 mm. wide, narrowed toward the base, slenderly long-attenuate at the apex, pale green or glaucescent, becoming much colored with purple, smooth, or slightly roughened on both surfaces toward the scabrous apex, the margins minutely serrulate-scabrous except towards the very smooth base which is often finely canescent in the throat but never pilose; ligule a very short, dense fringe of scarious hairs; sheaths very smooth and glabrous, compressed and keeled, the lower mostly longer than the internodes, the upper ones shorter; nodes dark; basal internodes often less than 3 cm. long, those above gradually longer, the upper ones often 1–1.8 dm. in length; peduncles very slender, exserted 1.5–3.5 dm., slightly

roughened towards the top and finely pubescent just below the spike; spike rather slender, even slightly flexuous, 2.5–7 cm. long, about 5 mm. thick or across the bristles 1.5 cm., simple, the rachis and pedicels of the spikelets finely hispidulous-pubescent; spikelets single or rarely two together, on pedicels 0.5 mm. long, about 2.5 mm. long, and 1.25 mm. wide; first scale ovate, acute or obtuse, 3-nerved, about one-half the length of the flower; second scale acute, 3-nerved or imperfectly 5-nerved, two-thirds to three-fourths the length of the subequal third and fourth scales; third scale 5-nerved, ovate-oblong, incurved-apiculate; fourth scale ovate-oblong, rather pointed, boat-shaped, the depth slightly more than half the width, the dorsal curve gradually descending, often with a slight concavity, into the somewhat beak-like incurved-apiculate apex, finely transversely rugulose, and obscurely 3-nerved, at maturity deep purple, at least toward the end, giving the spikes a squarrulose appearance; bristles in two nearly united clusters of mostly 5 bristles each, very slender, 6–10 mm. long, ascending or spreading, pale yellowish-green or sometimes purplish. (Plate 329.)

Plants that have been cut early in the season later become closely fastigiate-branched from the base, and bear shorter and thicker spikes and more purplish bristles.

Borders of salt and brackish marshes Van Cortlandt Park and Kingsbridge, New York City; Green's Farms, Connecticut, on Long Island Sound; also in Florida.

From the manner of its occurrence at New York and in Connecticut this grass has every appearance of being a common coastwise species. That it has hitherto been overlooked is to be explained through its similarity to *C. viridis* and *C. glauca*. With the former it is not closely related and need not be critically compared. Its affinity with *C. glauca* is much closer, yet it is perfectly distinct. It differs from *C. glauca* mainly in its perennial instead of annual underground system, more slender culms, much narrower and paler leaves, never pilose at the base, more slenderly peduncled spike, which is narrower and less densely flowered, the spikelets smaller, especially narrower and less gibbous, the scales somewhat different in relative length and venation, the glume of the perfect flower much less convex and rugose and becoming deep purple, the bristles longer and weaker and never tawny-orange as in *C. glauca*.

*Chaetochloa versicolor* finds its nearest relative in the following imperfectly known species of the Southern States:

CHAETOCHLOA PERENNIS (Curtiss).

*C. glauca* var. *perennis* Curtiss in Beal's Grasses of North America, 2: 156. 1896.

This grass, although very near to *C. versicolor*, differs in some noteworthy characters. It is even paler and more glaucous and grows in dense erect tufts, the culms closely branched from the base; the lower sheaths are more broadly flattened, the leaves broader and less attenuate and provided towards the base with long white hairs arising singly from scattered papillae; the ligule is sometimes scarcely fringed; the spikes are often longer, the spikelets at full maturity broader and less pointed, oblong or obovate-oblong and obtuse, the first and second scales shorter, broader and more obtuse, the second one 5–7-nerved instead of mostly 3-nerved, the glume of the perfect flower finely rugulose and remaining green at maturity or sometimes merely tipped with purple. The shorter first and second scales, as compared with *C. versicolor*, seem to be perfectly constant; the first scale is about one-third the length of the spikelet, the second scale one-half its length; in *C. versicolor* the respective scales are one-half and two-thirds or three-quarters the length of the spikelet.

Mr. George V. Nash, who has endeavored to ascertain whether this apparently common grass has not had some previous history, points out to me that it is apparently the same as Muhlenberg's *Panicum laevigatum* in Elliott's Bot. S. C. and Ga. 1: 112. 1817; Muhlenberg's name is preoccupied, however, by *Panicum laevigatum* of Lamarck (Fl. France, 3: 578. 1778). In the herbarium of Columbia University is a sheet from the Torrey Herbarium holding a flowering specimen of a *Chaetochloa* labeled *Panicum laevigatum* apparently in Elliott's handwriting and bearing his name in a corner of the label. This, if not part of Elliott's type, at least may be taken to be authentic material and, though very young, is certainly to be referred to the plant here raised to specific rank. Another sheet from Chapman's herbarium bearing imperfect specimens of apparently the same thing is labeled *Setaria glauca*, var. *laevigata*, coast of Florida. Still other specimens are labeled *Setaria flava* Kunth, a grass unknown to me, but which Mr. Nash assures me is quite a different South American species.

roughened towards the top and finely pubescent just below the spike; spike rather slender, even slightly flexuous, 2.5–7 cm. long, about 5 mm. thick or across the bristles 1.5 cm., simple, the rachis and pedicels of the spikelets finely hispidulous-pubescent; spikelets single or rarely two together, on pedicels 0.5 mm. long, about 2.5 mm. long, and 1.25 mm. wide; first scale ovate, acute or obtuse, 3-nerved, about one-half the length of the flower; second scale acute, 3-nerved or imperfectly 5-nerved, two-thirds to three-fourths the length of the subequal third and fourth scales; third scale 5-nerved, ovate-oblong, incurved-apiculate; fourth scale ovate-oblong, rather pointed, boat-shaped, the depth slightly more than half the width, the dorsal curve gradually descending, often with a slight concavity, into the somewhat beak-like incurved-apiculate apex, finely transversely rugulose, and obscurely 3-nerved, at maturity deep purple, at least toward the end, giving the spikes a squarrulose appearance; bristles in two nearly united clusters of mostly 5 bristles each, very slender, 6–10 mm. long, ascending or spreading, pale yellowish-green or sometimes purplish. (Plate 329.)

Plants that have been cut early in the season later become closely fastigiate-branched from the base, and bear shorter and thicker spikes and more purplish bristles.

Borders of salt and brackish marshes Van Cortlandt Park and Kingsbridge, New York City; Green's Farms, Connecticut, on Long Island Sound; also in Florida.

From the manner of its occurrence at New York and in Connecticut this grass has every appearance of being a common coastwise species. That it has hitherto been overlooked is to be explained through its similarity to *C. viridis* and *C. glauca*. With the former it is not closely related and need not be critically compared. Its affinity with *C. glauca* is much closer, yet it is perfectly distinct. It differs from *C. glauca* mainly in its perennial instead of annual underground system, more slender culms, much narrower and paler leaves, never pilose at the base, more slenderly peduncled spike, which is narrower and less densely flowered, the spikelets smaller, especially narrower and less gibbous, the scales somewhat different in relative length and venation, the glume of the perfect flower much less convex and rugose and becoming deep purple, the bristles longer and weaker and never tawny-orange as in *C. glauca*.

*Chaetochloa versicolor* finds its nearest relative in the following imperfectly known species of the Southern States:

CHAETOCHLOA PERENNIS (Curtiss).

*C. glauca* var. *perennis* Curtiss in Beal's Grasses of North America, 2: 156. 1896.

This grass, although very near to *C. versicolor*, differs in some noteworthy characters. It is even paler and more glaucous and grows in dense erect tufts, the culms closely branched from the base; the lower sheaths are more broadly flattened, the leaves broader and less attenuate and provided towards the base with long white hairs arising singly from scattered papillae; the ligule is sometimes scarcely fringed; the spikes are often longer, the spikelets at full maturity broader and less pointed, oblong or obovate-oblong and obtuse, the first and second scales shorter, broader and more obtuse, the second one 5–7-nerved instead of mostly 3-nerved, the glume of the perfect flower finely rugulose and remaining green at maturity or sometimes merely tipped with purple. The shorter first and second scales, as compared with *C. versicolor*, seem to be perfectly constant; the first scale is about one-third the length of the spikelet, the second scale one-half its length; in *C. versicolor* the respective scales are one-half and two-thirds or three-quarters the length of the spikelet.

Mr. George V. Nash, who has endeavored to ascertain whether this apparently common grass has not had some previous history, points out to me that it is apparently the same as Muhlenberg's *Panicum laevigatum* in Elliott's Bot. S. C. and Ga. 1: 112. 1817; Muhlenberg's name is preoccupied, however, by *Panicum laevigatum* of Lamarck (Fl. France, 3: 578. 1778). In the herbarium of Columbia University is a sheet from the Torrey Herbarium holding a flowering specimen of a *Chaetochloa* labeled *Panicum laevigatum* apparently in Elliott's handwriting and bearing his name in a corner of the label. This, if not part of Elliott's type, at least may be taken to be authentic material and, though very young, is certainly to be referred to the plant here raised to specific rank. Another sheet from Chapman's herbarium bearing imperfect specimens of apparently the same thing is labeled *Setaria glauca*, var. *laevigata*, coast of Florida. Still other specimens are labeled *Setaria flava* Kunth, a grass unknown to me, but which Mr. Nash assures me is quite a different South American species.

## Fabroleskea, a new Genus of Mosses.*

By G. N. Best.

Small plants in intricate spreading, pale to dark green tufts. Stems undulate creeping, irregularly divided and sparingly branched; stem leaves spreading-recurved, ovate-lanceolate, narrowly acuminate; costa thin, narrow, disappearing above the middle; leaf cells stoutly unipapillate on both surfaces; capsule erect, symmetric; pseudannulus of seven rows of oblong-oval, compressed, yellowish cells; peristome of sixteen yellowish lanceolate obtuse teeth, deeply inserted and densely covered with stiped papillae; dorsal line faint; ventral face scarcely lamellate; endostome a narrow band without segments or cilia; operculum short conic; calyptra tubular (?).

One species.

FABROLESKEA AUSTINI (Sulliv.) Best.

*Leskea Austini* Sulliv. Icon. Musc. 81. *pl. 61.* 1874.

Stems 2–3 cm. long, attached to substratum here and there by tufts of yellowish rhizoids; stem leaves concave, entire or sinuate-serrulate above, .7–1.2 mm. long, 3.5–.5 wide; leaf cells in rows, somewhat oblique, thick-walled, nearly uniform, basal and alar broadly oval to oval-quadrate; median elliptical-rhombic to rhomboidal-fusiform, .009–.011 mm. wide, .013–.016 long; apical linear-rhomboidal, monoicous; perichetial bracts oblong-lanceolate, slenderly acuminate, scarcely costate, margins sinuate-dentate.; pedicels erect, smooth, yellow-red, twisted above to the right when dry, 7–9 mm. long; capsule narrow-mouthed, brownish, oval-oblong, 1.5 mm. long, 0.6 wide, with 4–6 stomata at its base; pseudannulus separating between the second and third rows of cells from above; teeth .185 mm. long, .035 wide, confluent at base; endostome yellow, papillate, of 4 rows of oblong-rectangular cells .055 mm. broad; exothecial cell multiform, walls more or less curved, seldom straight; spores minutely roughened, .019–.026 mm.

Matures in late winter and early spring on trunks, rocks and limestone fences.

Widely distributed, yet local and variable. Illinois (Wolf);

* Based on specimens in the herbarium of Columbia University.

Minnesota (Holzinger); New York (Austin); New Jersey (Austin); Pennsylvania (Rau, Wolle) and South Carolina (Ravenel).

Type locality, Illinois.

EXSIC. Aust. Musc. Appalach. 267.

ILLUST. Sulliv. Icon. Musc. Supp. *pl. 61.* 1874.

REMARKS. Gemmae, more or less abundant, often in clusters, are present in most specimens. Fruiting plants collected by Mr. Holzinger at Winona, Minn., have the leaves somewhat smaller and the peristome less densely papillate. On some of the older deoperculate capsules the teeth are whitish and nearly destitute of papillae, as if these were deciduous as the result of prolonged exposure.

The gametophyte characters of *Fabroleskea Austini* indicate that it belongs to the Leskeaceae, while the sporophytes point to the Fabroniaceae, differing, however, from the latter by its papillate peristome, which resembles very closely those of certain species of *Orthotrichum*. Sullivant* remarks that "the generic position of this species is still uncertain, related as it is by some of its characters to *Leskea*, by others to *Habrodon*." Lesquereux and James† make the same observation.

The pseudannulus of *Fabroleskea Austini* is analagous to the cells about the mouth of *Fabronia pusilla*, but is much better developed and more distinct, yet not so well as in either *Habrodon* or *Clasmatodon*. The loose exothecial cells are almost identical with those of *Habrodon perpusillus*. It is, therefore, perhaps advisable, in the present state of our knowledge, to refer it as an outlying genus of the Fabroniaceae.

ROSEMONT, N. J.

* Icon. Musc. Supp., 81. 1874.

† Man. of N. A. Mosses, 303. 1884.

## The Mycorhizae of Aplectrum.*

D. T. MacDougal.

In April, 1876, Mr. H. Gilman collected a specimen of *Aplectrum spicatum* near Detroit, Mich., which he described in the Bulletin of the Torrey Botanical Club, **6**:94. 1876, as being furnished with coralloid roots, and as parasitic on the roots of trees. The specimens was sent to Dr. Gray, who informed Mr. Gilman that such formations were "indeed unexpected," and the matter rested.

I have recently rediscovered this formation on a clump of plants near Lake Minnetonka, and my preliminary examination reveals much of interest concerning this variation in form, as well as some important facts concerning the general biology of the typical plant.

The normal plant of *Aplectrum* consists of a small compressed globose corm bearing a single flower stalk in May, and a leaf arising in August persistent throughout the winter. The corm gives off one or two lateral offshoots, upon the ends of which daughter corms arise, repeating the history of the parent corm.

The plant lives in humus, and it appears that it must be considered a hemi-saprophyte, both from anatomical and experimental evidence, although work upon this point is not complete.

The short straight unbranched roots are from ten to sixteen in number, and arise from the lower part of the corm. These organs entertain two fungi in such manner as to form an ectotropic and an endotropic mycorhiza. The endotropic fungus forms masses of hyphae nearly filling the greater number of the cortical cells of the root, and sending single filaments out through the root hairs into the humus soil. The nuclei of the cortical cells containing the fungus are very large and hyperchromatic, and it is evident that the fungus is beneficial to the tissue inhabited by it. Its gen-

*Preliminary notice read before the Indiana Academy of Science, December 30, 1897.

eral arrangement resembles that of the underground stems of *Corallorhiza*.

The brown hyphae from the mycorhiza of neighboring trees adhere and penetrate the epidermis of the roots in patches in such manner as to make it appear that the *Aplectrum* is parasitic upon the trees as suggested by Mr. Gilman. I find, however, that the fungus simply adheres to the roots of both plants and that the *Aplectrum* is parasitic upon the tree only in the remote sense that it is a competitor for the organic substances absorbed by the fungal symbiont from the soil. This last named fungus forms complete coatings on the roots of oaks and maples and penetrates the soil in every direction, adhering to the roots of *Aplectrum* when these are met.

The variation in the species, which forms the chief interest of this paper, is due to the manner in which the endotropic fungus is transmitted from the parent to young plants through the offshoots.

The offshoot is usually a cylindrical smooth stem 1–2 cm. in length, consisting of about three internodes. The cortical cells in normal plants are seen to be filled with the hyphal masses increasing in number from the apical end of the offshoot toward the younger plant. Since no trichomes are present, the hyphae do not pass outwardly and into the soil. An examination near the base of the offshoot on the lower side reveals a small clump of hairs which are directed downward and toward the roots of the parent plant. The fungus in these roots sends hyphae out into the soil, which, meeting the clump of hairs on the offshoot, penetrate through them into the cortical tissues, thence penetrating the offshoot lengthwise to the apex, passing into the roots of the young plant directly, since these organs arise from the apex of the offshoot. By this arrangement the fungus is confined to the absorbing organs and does not gain access to the storage tissues of the corm.

Now, it is to some disturbance in the relations of the fungus in transit through the offshoot that the coralloid formations are due. In such instance the offshoot develops numerous branches consisting of a relatively large number of internodes. The epidermis has developed an enormous number of trichomes resem-

bling root hairs. The fungus sends hyphae out through these hairs and it is to be seen that the offshoot has been converted into an absorbing organ quite similar in structure and appearance to the underground stems of *Corallorhiza*. Other anatomical indications of the change in function are to be found.

It is, of course, readily apparent that, if these structural relations are transmissible, we have here a method by which *Aplectrum* may easily pass from a hemi-saprophyte into a complete dependence upon organic food with loss of chlorophyl. The writer will report further upon various anatomical and ecological features of the plant as soon as experiments now in progress are completed.

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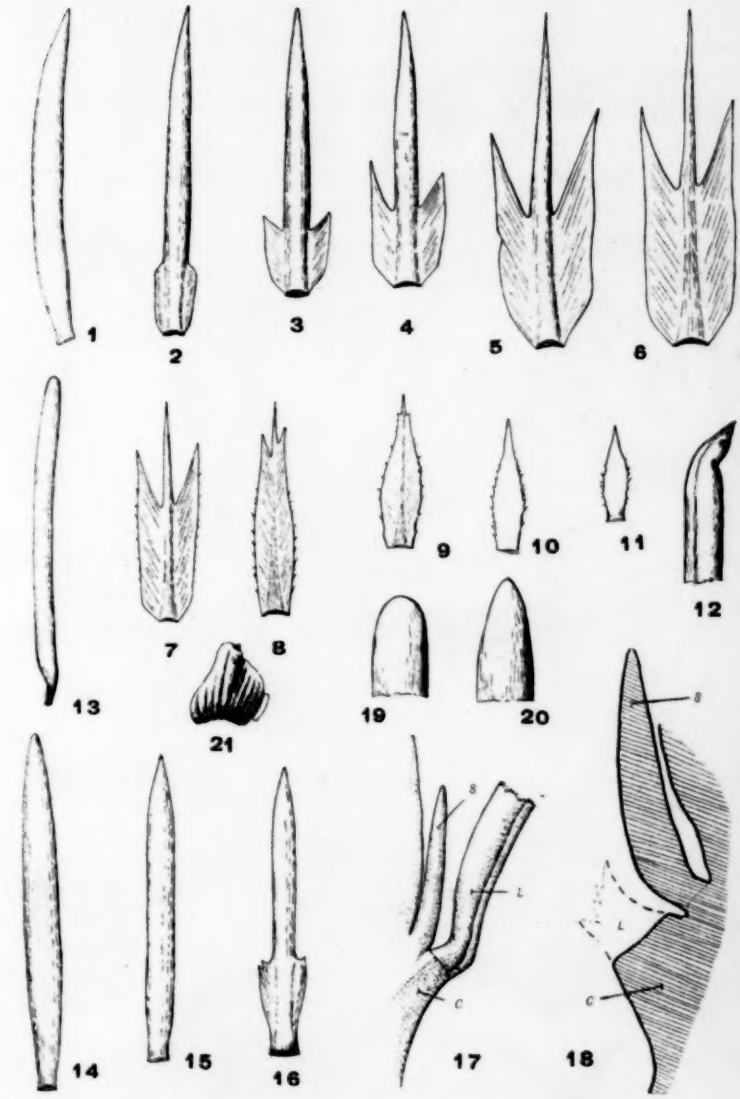


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